

DIN EN 16602-70-61

ICS 25.160.50; 49.140

Entwurf

Einsprüche bis 2021-11-17
 Vorgesehen als Ersatz für
 DIN EN 16602-70-07:2015-01,
 DIN EN 16602-70-08:2015-05 und
 DIN EN 16602-70-38:2019-11

**Raumfahrtproduktsicherung –
 Hochzuverlässiges Löten von Oberflächen-Befestigungen und
 Durchgangslochverbindungen;
 Englische Fassung prEN 16602-70-61:2021**

Space product assurance –
 High-reliability soldering for surface mount, mixed technology and hand-mounted electrical connections;
 English version prEN 16602-70-61:2021

Assurance produit spatiale –
 Assamblage haute fiabilité pour technologies à montage de surface et connexions traversantes;
 Version anglaise prEN 16602-70-61:2021

Anwendungswarnvermerk

Dieser Norm-Entwurf mit Erscheinungsdatum 2021-09-17 wird der Öffentlichkeit zur Prüfung und Stellungnahme vorgelegt.

Weil die beabsichtigte Norm von der vorliegenden Fassung abweichen kann, ist die Anwendung dieses Entwurfs besonders zu vereinbaren.

Stellungnahmen werden erbeten

- vorzugsweise online im Norm-Entwurfs-Portal von DIN unter www.din.de/go/entwuerfe bzw. für Norm-Entwürfe der DKE auch im Norm-Entwurfs-Portal der DKE unter www.entwuerfe.normenbibliothek.de, sofern dort wiedergegeben;
- oder als Datei per E-Mail an nl@din.de möglichst in Form einer Tabelle. Die Vorlage dieser Tabelle kann im Internet unter www.din.de/go/stellungnahmen-norm-entwuerfe oder für Stellungnahmen zu Norm-Entwürfen der DKE unter www.dke.de/stellungnahme abgerufen werden;
- oder in Papierform an den DIN-Normenausschuss Luft- und Raumfahrt (NL), 10772 Berlin oder Am DIN-Platz, Burggrafenstr. 6, 10787 Berlin.

Die Empfänger dieses Norm-Entwurfs werden gebeten, mit ihren Kommentaren jegliche relevanten Patentrechte, die sie kennen, mitzuteilen und unterstützende Dokumentationen zur Verfügung zu stellen.

Gesamtumfang 257 Seiten

DIN-Normenausschuss Luft- und Raumfahrt (NL)

Nationales Vorwort

Dieses Dokument (prEN 16602-70-61:2021) wurde vom Technischen Komitee CEN-CLC/JTC 5 „Raumfahrt“ erarbeitet, dessen Sekretariat von DIN (Deutschland) gehalten wird.

Das zuständige deutsche Normungsgremium ist der Arbeitsausschuss NA 131-06-02 AA „Interoperabilität von Informations-, Kommunikations- und Navigationssystemen“ im DIN-Normenausschuss Luft- und Raumfahrt (NL).

Dieses Dokument (prEN 16602-70-61:2021) basiert auf ECSS-Q-ST-70-61C DIR1 + impl DRRs.

Dieses Dokument enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 nur die englische Originalfassung von prEN 16602-70-61:2021.

Dieses Dokument wurde speziell zur Behandlung von Raumfahrtsystemen erarbeitet und hat daher Vorrang vor jeglicher Europäischen Norm, die denselben Anwendungsbereich hat, jedoch über einen größeren Geltungsbereich (z. B. Luft- und Raumfahrt) verfügt.

Für die in diesem Dokument zitierten Dokumente wird im Folgenden auf die entsprechenden deutschen Dokumente hingewiesen:

ISO 9454-1:2016 siehe DIN EN ISO 9454-1:2016-07

ISO 14644-1:2015 siehe DIN EN ISO 14644-1:2016-06

Aktuelle Informationen zu diesem Dokument können über die Internetseiten von DIN (www.din.de) durch eine Suche nach der Dokumentennummer aufgerufen werden.

Änderungen

Gegenüber DIN EN 16602-70-07:2015-01, DIN EN 16602-70-08:2015-05 und DIN EN 16602-70-38:2019-11 wurden folgende Änderungen vorgenommen:

a) Zusammenführung und Aktualisierung von DIN EN 16602-70-07:2015-01, DIN EN 16602-70-08:2015-05 und DIN EN 16602-70-38:2019-11;

b) redaktionelle Änderungen.

Nationaler Anhang NA (informativ)

Begriffe und Abkürzungen

Die Benummerung der folgenden Begriffe und Abkürzungen ist identisch mit der Benummerung in der englischen Fassung.

3 Begriffe und Abkürzungen

3.1 Begriffe aus anderen Normen

- a) Für die Anwendung dieser Norm gelten die Begriffe nach ECSS-S-ST-00-01.
- b) Für die Anwendung dieser Norm gelten die Begriffe nach ECSS-Q-ST-60, besonders die folgenden Begriffe:
 - 1) handelsübliche Komponente
- c) Für die Anwendung dieser Norm gelten die Begriffe nach ECSS-Q-ST-70-28, besonders die folgenden Begriffe:
 - 1) Reparatur
 - 2) Nacharbeit

3.2 Für diese Norm spezifische Begriffe

3.2.1

Zulassungsbehörde

Einrichtung, die auf der Grundlage der Bewertung der Prüfergebnisse das Verifizierungsprogramm überprüft und annimmt sowie die endgültige Zulassung erteilt

3.2.2

empfindliche Komponente der Baugruppe

Komponente, die anfällig für Risse in der Lötstelle ist, die 75 % der Annahmekriterien von Lotrissen überschreiten, oder eine Nichtkonformität außerhalb der Grenzen des Herstellers der Komponente aufweist

Anmerkung 1 zum Begriff: Eine Auflistung der ESA über empfindliche Komponenten von Baugruppen findet sich zu Informationszwecken auf der ESCIES-Website, siehe www.escies.org.

Anmerkung 2 zum Begriff: Jedes Unternehmen führt seine eigene Liste der empfindlichen Komponenten von Baugruppen im PID.

3.2.3

Gabellötstützpunkt

Lötstützpunkt mit Schlitz oder Spalt, in den Drähte oder Anschlüsse vor dem Löten eingeführt werden

Anmerkung 1 zum Begriff: Die englischsprachige Benennung „split terminal“ ist ein Synonym.

3.2.4

Blase

Delaminierung in Form einer örtlich begrenzten Aufwölbung und Trennung zwischen jeglichen Schichten eines Basismaterials für die Laminierung in einer Leiterplatte

3.2.5

Verkleben

Prozess des Auftragens von Klebstoff unterhalb eines Gehäuses für mechanische oder thermische Anwendung

3.2.6

Brückenbildung

Lotansammlung oder Umhüllung zwischen Komponenten und Komponentenanschlüssen oder dem Basismaterial, die einen erhöhten Steg bildet

3.2.7

umgebogener Anschluss

Leiter oder Komponentenanschluss, der durch eine Leiterplatte hindurchgeführt und dann umgebogen wird, um den Kontakt mit dem Lötauge der Leiterplatte herzustellen

Anmerkung 1 zum Begriff: Der umgebogene Teil muss nicht flach auf dem Lötauge aufliegen, und vor dem Löten dieser Art von Anschlüssen ist ein gewisses immanentes Rückfedern wünschenswert.

3.2.8

kalter Fluss

Bewegung der Isolierung

Anmerkung 1 zum Begriff: Zum Beispiel Teflon® (PTFE), hervorgerufen durch Druck.

3.2.9

kalte Lötverbindung

Lötverbindung, bei der das Lot ein stückiges, runzliges oder aufgeschichtetes Aussehen hat und Anzeichen eines mangelhaften Fließens oder einer mangelhaften Benetzung aufweist

Anmerkung 1 zum Begriff: Sie kann glänzend oder matt, jedoch nicht körnig aussehen. Sie weist gewöhnlich scharfe Grenzlinien anstelle von durchgehend glatten Hohlkehlen zwischen dem Lot und den zu verbindenden Flächen auf. Diese Linien werden entweder durch ungenügende Erwärmung oder dadurch hervorgerufen, dass ein Bereich der zu verbindenden Flächen die Löttemperatur nicht erreicht.

3.2.10

Umhüllung

konforme Schutzschicht

dünner Polymerfilm, der auf eine bestückte Leiterplatte aufgebracht wird und sich der Form der Oberfläche anpasst, die er bedeckt

3.2.11

Komplanarität

maximaler Abstand zwischen dem am niedrigsten und dem am höchsten gelegenen Anschluss, wenn sich die Komponente auf einer ebenen Oberfläche befindet

3.2.12

Kollektivbaugruppe

Satz von Komponenten, die in einem Arbeitsgang auf die Leiterplatte gelötet wurden

3.2.13

kritischer Bereich

Bereich in der Lötstelle, in dem das Vorhandensein von Rissen und deren Ausmaß zur Annahme oder Rückweisung führt

3.2.14

Entnetzen

Zustand einer Lötfläche, auf der flüssiges Lot nicht fest haftet und der durch eine scharfe Grenze zwischen Lot und Leiter oder Lot und Lötstützpunkt/Anschlussfläche charakterisiert ist

Anmerkung 1 zum Begriff: Dies ist oft als matte Oberfläche mit Inseln von dickerem glänzendem Lot zu erkennen.

3.2.15

gestörte Lötverbindung

unzureichende Verbindung infolge Relativbewegung zwischen Leiter und Anschlussstelle während des Erstarrens des Lots

3.2.16

dynamische Wellenlötanlage

System zum Wellenlöten, bestehend aus Stationen zum Fluxen, zum Vorheizen und zum Löten mithilfe eines Transportbands

3.2.17

Luftstrecke

Abstand zwischen elektrisch unterschiedlichen Leitern auf den äußeren Schichten einer Leiterplatte

Anmerkung 1 zum Begriff: Der Abstand zwischen Leitern hängt von der Auslegungsspannung und den Wechselspannungs- bzw. Gleichspannungs-Spitzenwerten ab. Jede Nichteinhaltung der mindestens erforderlichen Luftstrecke infolge einer Nichtkonformität ist ein Fehlerzustand.

3.2.18

Hohlkehle

konkave Ansammlung eines glatten Materials zwischen zwei Oberflächen

Anmerkung 1 zum Begriff: Beispiel: Lotkehle zwischen einem Komponentenanschluss und einem Lötauge oder Lötstützpunkt bzw. Hohlkehle aus Umhüllungsmaterial zwischen einer Komponente und der Leiterplatte

3.2.19

Flussmittel

Material, das beim Löten den Oxidfilm entfernt, die Oberfläche gegen Oxidation schützt und bewirkt, dass das Lot die zu verbindenden Oberflächen benetzt

3.2.20

Glasmeniskus

Glaskehle der Dichtung eines äußeren Anschlusses am Gehäuse

Anmerkung 1 zum Begriff: Diese können bei Anschluss eines stromführenden Leiters als funktional oder, bei Isolierung des Lötauges, als nichtfunktional bezeichnet werden.

3.2.21

modale Prüfung

Charakterisierung der dynamischen Eigenschaften von Systemen im Frequenzbereich

Anmerkung 1 zum Begriff: Ein typisches Beispiel ist die Prüfung von Strukturen unter Schwingungsanregung.

3.2.22

Outsourcing

Auslagerung

Vergabe von Arbeiten als Unteraufträge an ein anderes Unternehmen in Übereinstimmung mit dem PID des Kunden

3.2.23

„Pin-in-Paste“

„Stift in Lötpaste“

Prozess, bei dem eine Komponente mit Durchgangsbohrung im Prozess der Oberflächenmontage montiert und gelötet wird

3.2.24

Grübchen

kleine Löcher oder scharfkantige Vertiefungen in der Oberfläche des Lots

Anmerkung 1 zum Begriff: Grübchen können durch Ausblasen von eingeschlossenem oder überhitztem Flussmittel entstehen.

3.2.25

Vergussmasse

in der Regel elektrisch nichtleitende Masse zum Einbetten von oder als Füllstoff zwischen Komponenten, Leitern oder Baugruppen

3.2.26

Einpess-Steckverbinder

lötfreie Anschlusstechnik, bei der jeder Kontakt in ein durchmetallisiertes Loch einer Leiterplatte eingepresst wird, wodurch eine mechanische und elektrische Verbindung entsteht

3.2.27

Aufbereitung

Vorbereitungsmaßnahmen an einer Komponente vor der Montage

Anmerkung 1 zum Begriff: Goldentfernung, Vorverzinne, Formung und Abschneiden der Anschlussdrähte sind Beispiele für die Aufbereitung.

3.2.28

Abschirmung

metallische Umhüllung, die einen oder mehrere Draht/Drähte, Kabel, Kabelgruppe(n) oder eine Kombination aus Drähten und Kabeln umschließt und die zur Vermeidung oder Verringerung der Übertragung elektro-magnetischer Energie zu oder von den umhüllten Leitern dient

Anmerkung 1 zum Begriff: Die Abschirmung enthält auch eine Isolierung, die die metallische Umhüllung bedecken kann.

3.2.29

Lotperlen

Lotkugeln

mehrere Perlen aus Lötmetall, die nicht mit der Lötstelle verschmolzen sind und um die Lötstelle herum verteilt sind, in der Regel durch die Rückstände des Flussmittels anhaftend

Anmerkung 1 zum Begriff: Kann durch nicht ordnungsgemäßes Vorheizen oder durch mangelhafte Lotqualität verursacht werden.

3.2.30

Lötbecher

an einem Ende verschlossener hohler zylindrischer Lötstützpunkt, der einen oder mehrere Leiter aufnehmen kann

3.2.31

Eiszapfen

kegelförmige Lotspitze oder scharfkantige Lötstelle, die gewöhnlich durch vorzeitige Kühlung und Erstarrung von Lot beim Entfernen der Wärmequellen entsteht

3.2.32

Lötauge

leitende Oberfläche auf einer Leiterplatte, an die Anschlüsse gelötet werden, um elektrischer Verbindungen zu herzustellen

3.2.33

Lotüberstand

Dicke des Lots zwischen der Unterseite des Komponentenanschlusses und dem Lötauge

3.2.34

Gabellötstützpunkt

siehe „Gabellötstützpunkt“ 3.2.3

3.2.35

Kontaktnieten

Prozess des Auftragens von Klebstoff auf der Außenseite eines Gehäuses für mechanische Anwendung

3.2.36

Spannungsentlastung

Verfahren oder Hilfsmittel zur Verringerung mechanischer Spannungen an gelöteten Anschlüssen oder Komponenten auf ein Mindestmaß

Anmerkung 1 zum Begriff: Im Allgemeinen in Form eines Bogens oder einer Schleife aus Massivdraht oder Litze in einem Komponentenanschluss, um den Abbau von Spannungen zwischen Anschlüssen zu erreichen, die z. B. durch Bewegung oder Wärmeausdehnung hervorgerufen werden.

3.2.37

Stiftlötstützpunkt

auf einer Leiterplatte stehender, durch diese hindurchgeführter Leiteranschluss

3.2.38

Technikmuster

Proben von Leiterplatten, die mit repräsentativer Technik bestückt wurden

3.2.39

Wärmeableiter

Komponente mit guter Wärmeleitung zur Ableitung der Wärme von einem zu lötenen Gegenstand

3.2.40

Turmlötstützpunkt

runder pfostenartiger gerillter Bolzen, um den die Leiter vor dem Löten gewickelt werden

3.2.41

Unterfüllung

Materialansammlung zwischen einer Komponente und dem Träger

3.2.42

Prüfplatte

mit Komponenten verbundener Träger, der einem Verifizierungsprogramm unterzogen wird

3.2.43

Dochtwirkung

Fließen von geschmolzenem Lot oder Reinigungslösung durch Kapillarwirkung

Anmerkung 1 zum Begriff: Dochtwirkung tritt beim Löten von Litze auf, wobei das Lot in die Litze hineingezogen wird, jedoch gewöhnlich an der Außenfläche der Litze nicht sichtbar ist. Die Dochtwirkung kann auch innerhalb des Bogens zur Spannungsentlastung bei Komponentenanschlüssen auftreten.

3.3 Abkürzungen

Für die Anwendung dieser Norm gelten die Abkürzungen nach ECSS-S-ST-00-01 und die folgenden Abkürzungen:

Abkürzung	Bedeutung
AAD	Bauelemente in Flächenarray-Bauweise (en: Area Array Device) ANMERKUNG Auch bekannt als „Flächenmatrix-Komponente“.
AOI	automatische optische Inspektion (en: Automatic Optical Inspection)
AWG	amerikanische Drahtnorm, amerikanische Drahtlehre (en: American Wire Gauge)
BGA	Kugel(gitter)anordnung (en: Ball Grid Array)
CBGA	Kugel(gitter)anordnung auf Keramik (en: Ceramic Ball Grid Array)
CCGA	Säulenordnung auf Keramik (en: Ceramic Column Grid Array)
CGA	Säulenordnung (en: Column Grid Array)
CLCC	Keramik-Chipträger mit Anschlussdrähten (en: Ceramic Leaded Chip Carrier)
CTE	Wärmeausdehnungskoeffizient (en: Coefficient of Thermal Expansion)
DCL	Liste deklarerter Komponenten (en: Declared Component List)
DIL	mit zwei Anschlussreihen/zweireihig
DIP	Gehäuse mit zwei Anschlussreihen/DIL-Gehäuse (en: Dual In Line)
DPAK	Dioden-Gehäuse (en: Diode Package)
DRD	Definition der Anforderungen an Dokumente (en: Document Requirement Definition)
EDX	energiedispersive Röntgenstrahlung
ETFE	Ethylen-Tetrafluorethylen (en: ethylene tetrafluoroethylene)
EPA	ESD-Schutzzone
ESD	elektrostatische Entladung (en: electrostatic discharge)
FEP	Fluorethylenpropylen (en: Fluorinated Ethylene Propylene)
FM	Flugmodell oder Flug-Hardware (en: Flight Model or flight hardware)
FP	Flatpack-Gehäuse/Flachgehäuse
JEDEC	US-amerikanische Organisation zur Standardisierung von Halbleitern (en: Joint Electron Component Engineering Council)
LCCC	Keramik-Chipträger ohne Anschlussdrähte (en: Leadless Ceramic Chip Carrier)

Abkürzung	Bedeutung
MELF	Metallelektrode flächengebunden ANMERKUNG MELF schließt die Benennungen „MiniMelf“ und „MicroMelf“ ein.
MIP	(verbindlich) vorgeschriebener Prüfpunkt (en: Mandatory Inspection Point)
MPCB	Untersuchungsausschuss für Materialien, mechanische Teile und Prozesse (en: Materials, Mechanical Parts and Processes Control Board)
MRR	Überprüfung der Herstellungsbereitschaft (en: Manufacturing Readiness Review)
PCB	Leiterplatte (en: Printed Circuit Board)
PLCC	Kunststoff-Chipträger mit Anschlussdrähten (en: Plastic Leaded Chip Carrier)
PID	Prozessidentifikations-Dokument (en: Process Identification Document)
PSD	spektrale Leistungsdichte (en: Power Spectral Density)
PTFE	Polytetrafluorethylen (en: polytetrafluoroethylene)
PTH	Durchkontaktierungskomponente/Komponente mit durchmetallisierter Durchgangsbohrung (en: plated through hole component)
QFN	quadratisches Flachgehäuse ohne Anschlussdrähte (en: Quad Flat Pack No Leads)
QFP	quadratisches Flachgehäuse (en: Quad Flat Pack)
R_g	Widerstand gegen Erde (en: Resistance to ground)
R_s	Oberflächenwiderstand (en: Surface resistance)
r.m.s.	Effektivwert (en: root mean square)
SEM	Rasterelektronenmikroskop (en: Scanning Electronic Microscope)
SIR	Oberflächenisolationswiderstand (en: Surface Insulation Resistance)
SMD	oberflächenmontiertes Bauteil (en: Surface Mounted Device) ANMERKUNG Im Text dieses Dokuments wird anstelle von „Bauteil“ die Benennung „Komponente“ verwendet.
SMT	Oberflächenmontagetechnik (en: Surface Mount Technology)
SO	kleine Bauform (en: Small Outline)
SOD	Diode kleiner Bauform (en: Small Outline Diode)
SOT	Transistor kleiner Bauform (en: Small Outline Transistor)
SOP	Gehäuse kleiner Bauform (en: Small Outline Package)
TO	Transistorbauform (en: Transistor Outline)
TRB	Ausschuss für die Bewertung der Prüfung (en: Test Review Board)
TRR	Überprüfung der Prüfbereitschaft (en: Test Readiness Review)
TSOP	dünnes Gehäuse kleiner Bauform (en: Thin Small Outline Package)
RF	Hochfrequenz (en: Radio Frequency)

Nationaler Anhang NB (informativ)

Literaturhinweise

DIN EN ISO 9454-1:2016-07, *Flussmittel zum Weichlöten — Einteilung und Anforderungen — Teil 1: Einteilung, Kennzeichnung und Verpackung (ISO 9454-1:2016); Deutsche Fassung EN ISO 9454-1:2016*

DIN EN ISO 14644-1:2016-06, *Reinräume und zugehörige Reinraumbereiche — Teil 1: Klassifizierung der Luftreinheit anhand der Partikelkonzentration (ISO 14644-1:2015); Deutsche Fassung EN ISO 14644-1:2015*

October 2021

ICS 25.160.50; 49.140

Will supersede EN 16602-70-07:2014, EN 16602-70-08:2015, EN 16602-70-38:2019

English version

Space product assurance - High-reliability soldering for surface mount, mixed technology and hand-mounted electrical connections

Assurance produit spatiale - Assamblage haute fiabilité pour technologies à montage de surface et connexions traversantes

Raumfahrtproduktsicherung - Hochzuverlässiges Löten von Oberflächen-Befestigungen und Durchgangslochverbindungen

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/CLC/JTC 5.

If this draft becomes a European Standard, CEN and CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CEN and CENELEC in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN and CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN and CENELEC members are the national standards bodies and national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation. Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Warning : This document is not a European Standard. It is distributed for review and comments. It is subject to change without notice and shall not be referred to as a European Standard.



Table of contents

Table of contents	2
European Foreword	13
Introduction	14
1 Scope	21
2 Normative references	22
3 Terms, definitions and abbreviated terms	24
3.1 Terms from other standards.....	24
3.2 Terms specific to the present standard	24
3.3 Abbreviated terms.....	29
3.4 Nomenclature	30
4 Principles of reliable soldered connections	32
5 Preparatory conditions	33
5.1 Facility cleanliness.....	33
5.2 Environmental conditions.....	33
5.3 Lighting requirements	34
5.4 Precautions against static discharges	34
5.4.1 Overview	34
5.4.2 General	35
5.4.3 ESD Protected Area	35
5.4.4 Precautions against ESD during manufacturing	36
5.4.5 Protective packaging and ESD protection	37
5.5 Equipment and tools	37
5.5.1 General	37
5.5.2 Brushes.....	38
5.5.3 Cutters and pliers.....	38
5.5.4 Bending tools	39
5.5.5 Clinching tools.....	39
5.5.6 Insulation strippers	39

5.5.7	Hot air blower.....	41
5.5.8	Soldering tools	41
5.5.9	Baking and curing ovens	42
5.5.10	Solder deposition equipment.....	42
5.5.11	Automatic component placement equipment.....	42
5.5.12	Dynamic wave-solder machines.....	43
5.5.13	Selective wave solder equipment.....	43
5.5.14	Reflow process equipment.....	44
5.5.15	Depanelisation tool.....	46
5.5.16	Cleanliness testing equipment	46
5.5.17	Optical microscope.....	46
5.5.18	Automatic Optical Inspection (AOI) equipment.....	46
5.5.19	X-ray inspection equipment.....	47
6	Material selection	48
6.1	General.....	48
6.2	Solder	48
6.2.1	Form	48
6.2.2	Composition	49
6.2.3	Maintenance of paste purity	51
6.3	Fluxes.....	51
6.3.1	Rosin based fluxes.....	51
6.3.2	Application of flux.....	52
6.3.3	Flux controls for wave-soldering equipment	52
6.4	Solvents.....	53
6.5	Flexible insulation materials.....	53
6.6	Terminals.....	54
6.6.1	Materials	54
6.6.2	Tin, silver, and gold-plated terminals.....	54
6.7	Wires	55
6.8	Sculptured flex.....	55
6.9	Printed circuits substrates.....	55
6.9.1	Substrates selection	55
6.9.2	Gold finish on PCBs footprint	55
6.10	Components	56
6.10.1	General	56
6.10.2	Moisture sensitive components	56
6.11	Adhesives, potting, underfill and conformal coatings.....	57

7 Preparations prior to mounting and soldering	58
7.1 General handling	58
7.2 Storage.....	58
7.2.1 Components.....	58
7.2.2 PCBs.....	58
7.2.3 Materials requiring segregation	58
7.3 Baking conditions of PCBs.....	59
7.4 Baking and storage of moisture sensitive components	59
7.5 Preparation of components, wires, terminals, and solder cups.....	60
7.5.1 Insulation removal	60
7.5.2 Surfaces to be soldered	61
7.6 Degolding and pretinning	62
7.6.1 General	62
7.6.2 Solder baths method for degolding and pretinning of components terminations and terminals	62
7.6.3 Solder iron method for degolding and pretinning	63
7.6.4 Pretinning processes.....	64
7.7 Preparation of the soldering tip	65
8 Components mounting requirements prior to soldering	66
8.1 General requirements	66
8.2 Mounting of through hole components	66
8.2.1 General	66
8.2.2 Heavy components	66
8.2.3 Metal-case components	67
8.2.4 Glass-encased components.....	67
8.2.5 Stress relief of components with bendable leads.....	67
8.2.6 Stress relief of components with non-bendable leads.....	70
8.2.7 Bending of component leads.....	70
8.2.8 Lead attachment to PCBs	71
8.2.9 Mounting of swage terminals to PCBs.....	73
8.2.10 Mounting of through hole connectors to PCBs	73
8.2.11 Clinching of components in non-plated through holes	74
8.2.12 Mounting of components to terminals.....	76
8.3 Mounting of surface mount components	77
8.3.1 General	77
8.3.2 Lead forming	78
8.3.3 Mounting components in solder paste	78

8.3.4	Leadless components	78
9	Attachment of conductors to terminals, solder cups and cables	80
9.1	General.....	80
9.2	Wire termination	80
9.2.1	Breakouts from cables	80
9.2.2	Insulation clearance	80
9.2.3	Stress relief	81
9.3	Turret and straight-pin terminals	81
9.3.1	Side route	81
9.3.2	Bottom route	81
9.4	Bifurcated terminals	82
9.4.1	General	82
9.4.2	Bottom route	82
9.4.3	Side route	83
9.4.4	Top route	84
9.4.5	Combination of top and bottom routes.....	85
9.4.6	Combination of side and bottom routes	85
9.5	Hook terminals.....	85
9.6	Pierced terminals	85
9.7	Solder cups for connector	86
9.8	Insulation sleeving	87
9.9	Wire and cable interconnections	88
9.9.1	General	88
9.9.2	Preparation of wires	88
9.9.3	Preparation of shielded wires and cables	88
9.9.4	Pre-assembly	89
9.9.5	Soldering of conductors onto terminals except cup terminals	90
9.9.6	Soldering of conductors onto cup terminals.....	90
9.10	Connection of wires to PCBs	91
9.11	Connection of coaxial cables to PCBs	93
10	Assembly to terminals and to PCBs	94
10.1	Overview	94
10.2	General soldering conditions	94
10.3	Soldering of components, terminals, and wires into PCB through holes.....	97
10.3.1	General	97
10.3.2	Solder fillets for wires and terminations	98

10.3.3	Solder fillets for component leads in plated through-holes.....	98
10.3.4	Solder fillets for component leads in non-plated through-holes	99
10.3.5	PCB design requirements for wave and selective soldering	100
10.4	Soldering of surface mount components.....	100
10.4.1	General	100
10.4.2	Rectangular and square end-capped or end-metallized leadless chip	101
10.4.3	Cylindrical and square end-capped components with cylindrical or oval body	102
10.4.4	Bottom terminated chip components	105
10.4.5	L-Shape inwards components.....	106
10.4.6	Leadless component with plane termination.....	106
10.4.7	Leaded component with plane termination	107
10.4.8	Leadless castellated ceramic chip carrier components.....	108
10.4.9	No lead Quad Flat Pack	109
10.4.10	Flat pack and gull-wing leaded components with round, rectangular, ribbon leads	111
10.4.11	Components with “J” leads.....	112
10.4.12	Components with ribbon terminals without stress relief	113
10.4.13	Stacked modules components with leads protruding vertically from bottom.....	114
10.4.14	Area array devices	115
10.5	Rework and repair	116
10.5.1	Removal of solder on unpopulated PCB.....	116
10.5.2	Rework , repair and modifications	116
10.6	High-voltage connections.....	117
10.7	Solderless components	118
11	Post soldering process requirements	120
11.1	Cleaning of PCB assemblies	120
11.1.1	General	120
11.1.2	Verification of cleanliness.....	120
11.1.3	Surface Insulation Resistance (SIR) testing	121
11.1.4	Monitoring of cleanliness.....	121
11.1.5	Sodium chloride (NaCl) equivalent ionic contaminants testing	122
11.2	Staking and bonding	122
11.3	Conformal coating, potting and underfill	123
12	Final inspection	124
12.1	General.....	124

12.2	Visual acceptance criteria	124
12.3	Visual rejection criteria.....	125
12.4	X-ray rejection criteria	127
12.5	Warp and twist of populated boards.....	127
12.6	Inspection records	128
13	Verification procedure.....	129
13.1	Verification approval procedure	129
13.1.1	Request for verification	129
13.1.2	Technology sample.....	129
13.1.3	Audit of assembly processing.....	130
13.1.4	Verification programme documentation	130
13.1.5	Verification samples and testing.....	130
13.1.6	Final verification review	131
13.1.7	Approval of assembly line	132
13.1.8	Withdrawal of approval status	132
13.2	Verification programme.....	132
13.2.1	General	132
13.2.2	Verification for PTH manual soldering	138
13.2.3	Additional verification for wave soldering.....	138
13.2.4	Soldering log	138
13.3	Special verification testing for ceramic area array components.....	141
13.3.1	General	141
13.3.2	Evaluation of capability samples	143
13.3.3	Electrical verification	143
13.4	Component verification with electrical testing procedure.....	144
13.5	Verification programme with reduced temperature range.....	147
13.6	Verification for solderless process	147
13.7	Conditions for delta verification	149
13.8	Verification by similarity	152
13.8.1	General conditions for similarity	152
13.8.2	Conditions for similarity for PTH components.....	152
13.8.3	Conditions for similarity for SMD	153
13.8.4	Conditions for similarity for solderless components	156
14	Environmental tests conditions	157
14.1	Overview	157
14.2	Visual inspection.....	157

14.3	X-ray inspection	157
14.4	Cleanliness test	157
14.5	Warp and twist of PCB.....	157
14.6	Electrical continuity measurement	157
14.7	Electrical continuity for wave soldered multilayers PCB	158
14.8	Vibration	159
14.9	Mechanical shock	161
14.10	Damp heat test	162
14.11	Temperature cycling test.....	162
14.12	Temperature cycling test with reduced temperature range.....	163
14.13	Final visual inspection.....	165
14.14	Microsection	165
14.14.1	Microsection facilities	165
14.14.2	Microsections location.....	166
14.14.3	Microsection acceptance and rejection criteria	166
14.14.4	Microsection acceptance and rejection criteria for ceramic chip capacitors	180
14.14.5	Verification acceptance and rejection criteria	185
14.15	Anomalies in PCB and sculptured flex during verification.....	185
15	Outsourcing	187
15.1	General.....	187
16	Process identification document (PID)	189
16.1	General.....	189
16.1.1	Overview	189
16.1.2	Document preparation.....	189
16.1.3	Approval.....	189
16.1.4	Contact person.....	189
16.2	Process identification document update.....	189
17	Quality assurance.....	190
17.1	General.....	190
17.2	Data.....	190
17.3	Nonconformance	190
17.4	Calibration	190
17.5	Traceability	191
17.6	Workmanship standards	191
17.7	Inspection points.....	191

17.8 Operators, inspectors and instructors training and certification	191
17.9 Quality records	192
Annex A (normative) Verification programme - DRD	193
A.1 DRD identification	193
A.2 Expected response	193
Annex B (normative) Verification report - DRD	195
B.1 DRD identification	195
B.2 Expected response	195
Annex C (normative) Process Identification Documentation (PID) - DRD	197
C.1 DRD identification	197
C.2 Expected response	197
Annex D (normative) Assembly Summary Table – DRD	200
D.1 DRD identification	200
D.2 Expected response	200
Annex E (normative) Visual workmanship standards for through hole component	202
E.1 Soldered stud terminals	202
E.2 Soldered clinched terminals	203
E.3 Soldered turret terminals	204
E.4 Solder turret terminals	205
E.5 Soldered bifurcated terminals	206
E.6 Soldered hook terminals	207
E.7 Soldered cup terminals	208
E.8 Soldered wire to shielded cable interconnections	209
E.9 Assembly of Dual in Line Package	212
Annex F (informative) Visual and X-ray workmanship standards for SMDs	213
F.1 Workmanship illustrations for standard SMDs	213
F.2 X Ray Workmanship illustrations for solder flow and voids	232
F.3 X Ray Workmanship illustrations for ball grid array devices	233
F.4 Workmanship illustrations for column grid array devices	234
Annex G (informative) Example of an SMT audit report	236
Annex H (informative) Solder Alloys melting temperatures and choice	245
H.1 Melting temperatures and choice	245
Bibliography	246

Figures

Figure 5-1: Profile of correct cutters for trimming leads.....	39
Figure 5-2: Example of suitable mechanical strippers.....	40
Figure 8-1: Assembly of TO-39 and CKR06	68
Figure 8-2: TO package with underfill	68
Figure 8-3: Methods for incorporating stress relief with components having bendable leads	69
Figure 8-4: Methods for attaching wire extensions to non-bendable leads.....	70
Figure 8-5: Minimum lead bend	71
Figure 8-6: Stud leads	72
Figure 8-7: Types of terminal swaging	73
Figure 8-8: Leads with solder termination on both sides	74
Figure 8-9: Clinching with stress relief for component in non-plated hole	75
Figure 8-10: Minimum values of through-hole lapped terminations	76
Figure 8-11: Method of stress relieving components attached to terminals.....	77
Figure 8-12: Exposed element.....	79
Figure 9-1: Side- and bottom-route connections to turret terminals	82
Figure 9-2: Bottom route connections to bifurcated terminal	83
Figure 9-3: Side-route connection to bifurcated terminal.....	84
Figure 9-4: Top route connection to bifurcated terminal.....	84
Figure 9-5: Connections to hook terminals	85
Figure 9-6: Connections to pierced terminals	86
Figure 9-7: Connections to solder cups (connector type).....	87
Figure 9-8: Methods for securing wires.....	90
Figure 9-9: Connection of stranded wires to PCBs	91
Figure 9-10: Connection of coaxial cables to PCBs	93
Figure 10-1: Maximum tilt for assembled PTH component	95
Figure 10-2: Maximum tilt for assembled SMD component.....	95
Figure 10-3: Minimum acceptable wetting on component side.....	99
Figure 10-4: Mounting of rectangular and square end-capped and end-metallized components	101
Figure 10-5: Mounting of cylindrical end-capped components	103
Figure 10-6: Mounting of square end-capped components.....	104
Figure 10-7: Mounting of bottom terminated chip component	105
Figure 10-8: Mounting of components with “L-shape inwards” leads	106
Figure 10-9: Mounting of leadless component with plane termination.....	107
Figure 10-10: Mounting of leaded components with plane termination	108

Figure 10-11: Mounting of leadless castellated ceramic chip carrier components.....	109
Figure 10-12 Mounting of QFN	110
Figure 10-13: Mounting of gull-wing leaded components with round, rectangular, ribbon leads	111
Figure 10-14: Mounting of component with “J” leads	112
Figure 10-15: Mounting of components without stress relief	113
Figure 10-16: Mounting of stacked module components with leads protruding vertically from bottom.....	114
Figure 10-17: Typical configuration of ceramic grid array component	115
Figure 10-18: High voltage connection	118
Figure 10-19: Solderless assembly configuration	118
Figure 13-1 : Generic soldering verification flow	137
Figure 13-2: Example of soldering log for joints discrepancy log	140
Figure 13-3: Area Array component verification programme flow chart.....	142
Figure 13-4: Component verification with electrical testing procedure	146
Figure 13-5: Verification procedure for solderless technology.....	149
Figure 14-1:Vibration test flow chart	159
Figure D-1 : Example of component type preparation and mounting configuration	201
Figure E-1 : Soldered stud terminals	202
Figure E-2 : Soldered clinched terminals	203
Figure E-3 : Soldered turret terminals with twin conductors	204
Figure E-4 : Soldered turret terminals with single conductors	205
Figure E-5 : Soldered bifurcated terminals.....	206
Figure E-6 : Soldered hook terminals	207
Figure E-7 : Soldered cup terminals	208
Figure E-8 : Hand soldered wire to shielded cable interconnections.....	209
Figure E-9 : Hand soldered wire to shielded wire interconnections.....	210
Figure E-10 : Hand soldered wire interconnections - details of defects.....	211
Figure F-1 : Examples of minimum acceptable solder flow through and maximum voids during X-ray	232
Figure F-2 : Angled-transmission X-radiograph showing solder paste shadow due to partial reflow: Reject.....	233
Figure F-3 : Perpendicular transmission X-radiograph showing unacceptable defects	233
Figure F-4 : Perpendicular transmission X-radiograph showing non-wetted footprint.....	234
Figure F-5 : X-radiograph of CGA mounted on PCB showing solder bridge: Reject.....	234
Figure F-6 : X-radiograph of CGA showing solder fillets at base of columns: acceptable....	235

Tables

Table 5-1: Particle sizes classes 8 and 9 according to ISO 14644-1 (2015)	34
Table 5-2: EPA requirements summary	36
Table 6-1: Chemical composition of spacecraft solders	50
Table 6-2: Fluxes	52
Table 7-1: Clearances for insulation	61
Table 7-2: Solder baths parameters for degolding and pretinning	63
Table 8-1: Dimensions and tolerances for clinching component in non-plated hole	75
Table 9-1: Dimensions for connections of stranded wires to PCBs	92
Table 9-2: Dimensions for connections of coaxial cables to PCBs	93
Table 10-1: Dimensional and solder fillet for rectangular and square end capped components	102
Table 10-2: Dimensional and solder fillet for cylindrical end-capped components	103
Table 10-3: Dimensional and solder fillet for square end-capped components	104
Table 10-4: Dimensional and solder fillet for bottom terminated chip components	105
Table 10-5: Dimensional and solder fillet for “L-shape inwards” components	106
Table 10-6: Dimensional and solder fillet for leadless component with plane termination ...	107
Table 10-7: Dimensional and solder fillet for leaded components with plane termination....	108
Table 10-8: Dimensional and solder fillet for leadless castellated ceramic chip carrier components	109
Table 10-9: Dimensional and solder fillet for QFN components	110
Table 10-10: Dimensional and solder fillet for gull-wing leaded components with round, rectangular, ribbon leads	111
Table 10-11: Dimensional and solder fillet for components with “J” leads	112
Table 10-12: Dimensional and solder fillet for components with ribbon terminals without stress relief	113
Table 10-13: Dimensional and solder fillet for stacked module components with leads protruding vertically from bottom	114
Table 10-14: Dimensional and solder fillet for area array devices	116
Table 10-15: Placement for solderless components	119
Table 13-1: Conditions invoking verification	151
Table 14-1: Modal survey conditions	160
Table 14-2: Minimum severity for sine vibration testing	161
Table 14-3: Minimum severity for random vibration testing for all applications except launchers	161
Table 14-4: Component microsection location and acceptance criteria	168
Table 14-5: Acceptance criteria for internal defects in ceramic chip capacitors after microsectioning	181

European Foreword

This document (prEN 16602-70-61:2021) has been prepared by Technical Committee CEN/CLC/TC 5 “Space”, the secretariat of which is held by DIN (Germany).

This document (prEN 16602-70-61:2021) originates from ECSS-Q-ST-70-61C DIR1 + impl DRRs.

This document is currently submitted to the **ENQUIRY**.

This document will supersede EN 16602-70-07, EN 16602-70-08 and EN 16602-70-38.

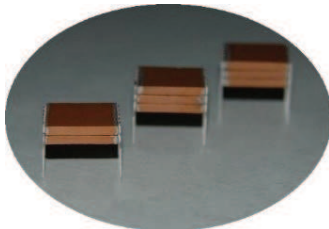
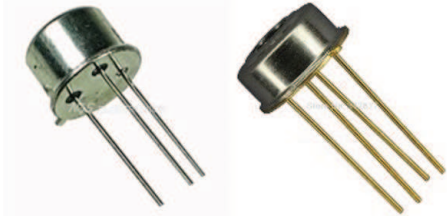
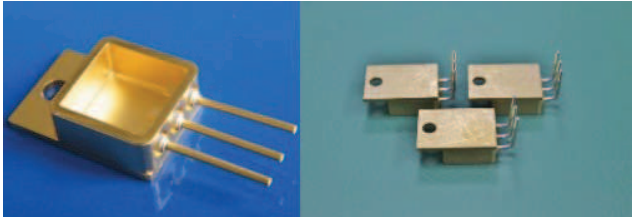
This document has been developed to cover specifically space systems and will therefore have precedence over any EN covering the same scope but with a wider do-main of applicability (e.g. : aerospace).

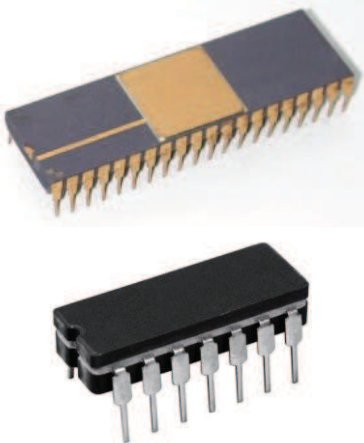
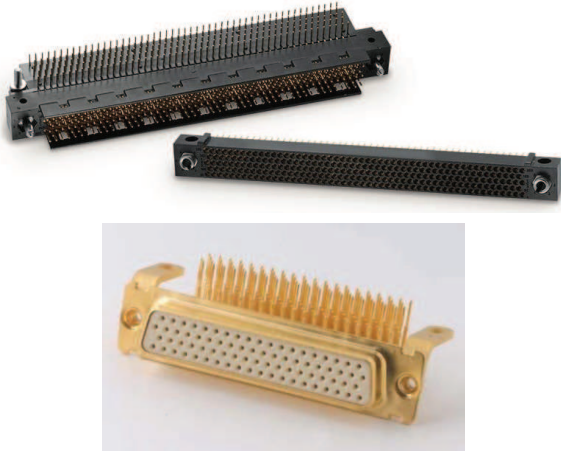
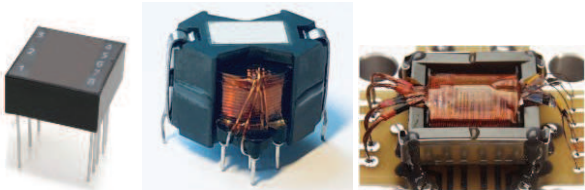
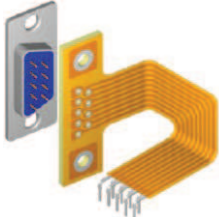
Introduction

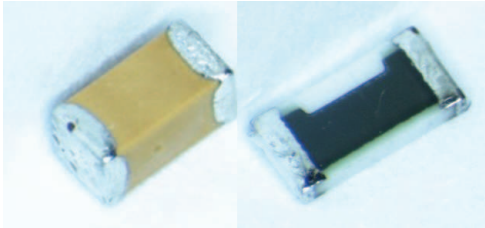
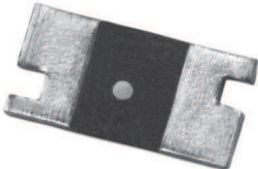
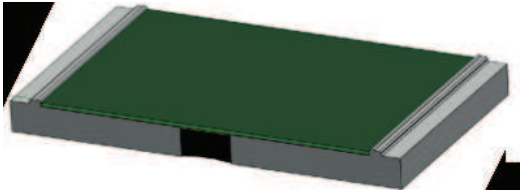
This document prescribes requirements for electrical connections of plated through hole components, for leadless, leaded surface mounted components and for solderless connection on spacecraft, launchers, and associated equipment.

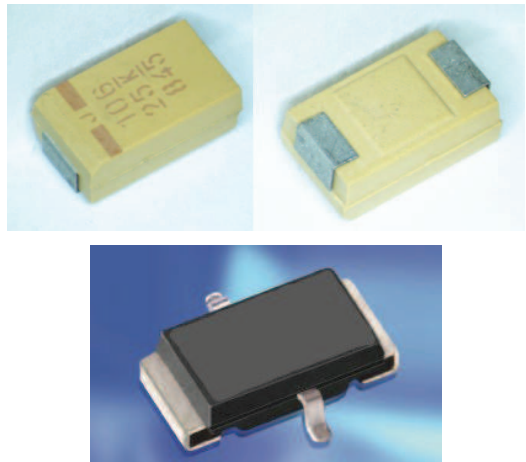
In the following table, principal types of through hole components and SMDs, including examples, can be gathered in the following families.

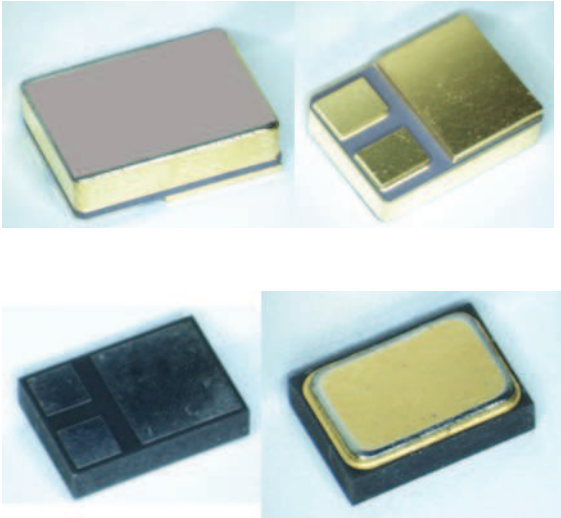
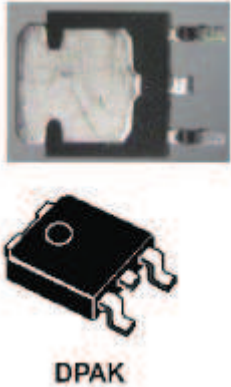
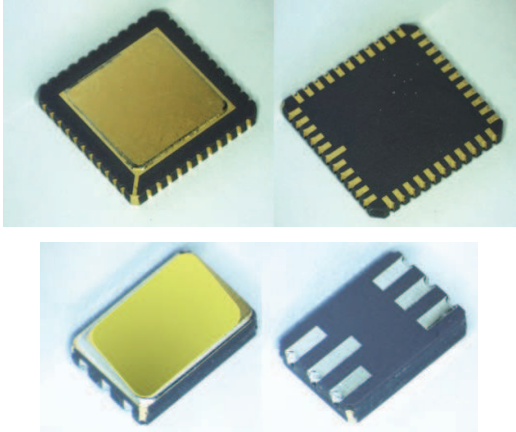
NOTE In the text of this document the term “component” is used instead of “device”.

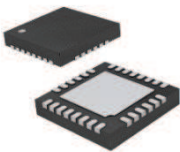
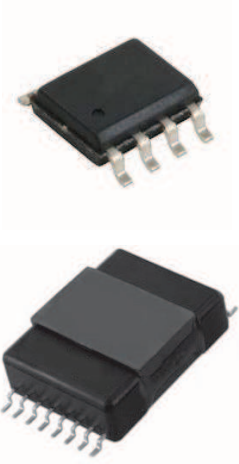
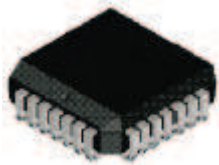
THROUGH HOLE COMPONENTS (non exhaustive list)	
Radial component resistors capacitors fuses diodes	
Axial component Capacitors resistors diodes	
Stacked capacitors CH capacitors CNC capacitors	
TO Metal Can package TO-39	
TO Metal tab package TO254	

THROUGH HOLE COMPONENTS (non exhaustive list)	
Dual in Line Package (DIL or DIP) Side brazed DIP	
Connectors	
Leaded magnetics transformers with straight pins	
Sculptured flex	

SMT COMPONENTS (non exhaustive list)	
<p>Rectangular and square end-capped or end-metallized component with rectangular body, leadless chip (see 10.4.2)</p> <p>ceramic end capped chip resistors and capacitors.</p> <p>ceramic resistors arrays</p> <p>metallic terminations fuses, thermistors CSM 2512</p> <p>metallic termination resistor SMS 2512</p>	   
<p>Cylindrical and square end-capped components with cylindrical or oval body, leadless chip (see 10.4.3)</p> <p>MELF for cylindrical end capped:</p> <ul style="list-style-type: none"> Diodes in MELF, minimelf or micromelf 	

SMT COMPONENTS (non exhaustive list)	
<ul style="list-style-type: none"> Resistors in MELF, minimelf or micromelf <p>Square end capped:</p> <ul style="list-style-type: none"> D-5A for square end capped with cylindrical or oval bodies 	
<p>Bottom terminated chip component (see 10.4.4)</p> <p>This type of component has metallised terminations on the bottom side only)</p> <p>Chip inductors</p>	
<p>Component with inward formed L-shaped leads (see 10.4.5)</p> <p>moulded tantalum chip capacitors.</p> <p>SMD moulded shunt</p>	

SMT COMPONENTS (non exhaustive list)	
<p>Leadless component with plane termination (see 10.4.6)</p> <ul style="list-style-type: none"> - With metal plane termination: SMD0.5, SMD1, SMD2, SMD0.2*(TO276 JEDEC family denomination) - With non-metal plane termination: SMD0.2* <p>*package exists in two versions</p>	
<p>Leaded component with plane termination (see 10.4.7)</p> <p>Diode PackAge (DPAK or TO252)</p>	 <p>DPAK</p>
<p>Leadless castellated ceramic chip carrier component (see 10.4.8)</p> <p>The main component of this type is leadless ceramic chip carrier (LCCC)</p> <p>LCC6</p>	

SMT COMPONENTS (non exhaustive list)	
<p>No lead QFN (see 10.4.9)</p> <p>quad flat pack no leads</p>	
<p>Flat pack and gull-wing leaded component (see 10.4.10)</p> <p>small-outline transistor (SOT), small — outline package (SO), flat pack and quad flat pack (QFP) and SMD connectors with stress-relief.</p> <p>transformers</p> <p>Components with both flat rectangular and round leads are included in this group. The leads can both be pre-formed by the manufacturer or straight leads which are in-house preformed</p>	
<p>“J” leaded component (see 10.4.11)</p> <p>ceramic leaded chip carriers (CLCC) and plastic leaded chip carriers (PLCC).</p>	
<p>Components with ribbon terminals without stress relief (flat lug leads) (see 10.4.12)</p> <p>This package has flat leads extending from the sides</p>	

1

Scope

This Standard defines the technical requirements and quality assurance provisions for the manufacture and verification of high-reliability electronic circuits of surface mount, through hole and solderless assemblies.

The Standard defines workmanship requirements, the acceptance and rejection criteria for high-reliability assemblies intended to withstand ground testing conditions including LTS (long term storage) and the environment imposed by space flight.

The mounting and supporting of components, terminals and conductors specified in this standard applies only to assemblies designed to continuously operate over the mission within the temperature limits of -55 °C to +85 °C at solder joint level.

Requirements related to printed circuit boards are contained in ECSS-Q-ST-70-60 and ECSS-Q-ST-70-12.

This Standard does not cover the qualification and acceptance of the EQM and FM equipment with high-reliability electronic circuits of surface mount, through hole and solderless assemblies.

This Standard does not cover verification of thermal properties for component assembly.

This Standard does not cover pressfit connectors.

The qualification and acceptance tests of equipment manufactured in accordance with this Standard are covered by ECSS-E-ST-10-03.

This standard may be tailored for the specific characteristics and constraints of a space project, in accordance with ECSS-S-ST-00.

Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS Standard. For dated references, subsequent amendments to, or revision of any of these publications do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the more recent editions of the normative documents indicated below. For undated references, the latest edition of the publication referred to applies.

EN reference	Reference in text	Title
EN 16601-00-01	ECSS-S-ST-00-01	ECSS system — Glossary of terms
EN 16601-40	ECSS-M-ST-40	Space project management — Configuration and information management
EN 16602-10-09	ECSS-Q-ST-10-09	Space product assurance — Nonconformance control system
EN 16602-20	ECSS-Q-ST-20	Space product assurance — Quality assurance
EN 16602-60	ECSS-Q-ST-60	Space product assurance — Electrical, electronic and electromechanical (EEE) components
EN 16602-60-05	ECSS-Q-ST-60-05	Space product assurance — Generic requirements for hybrids
EN 16602-60-13	ECSS-Q-ST-60-13	Space product assurance — Commercial electrical, electronic and electromechanical (EEE) components
EN 16602-70	ECSS-Q-ST-70	Space product assurance — Materials, mechanical parts and processes
EN 16602-70-01	ECSS-Q-ST-70-01	Space product assurance — Cleanliness and contamination control
EN 16602-70-02	ECSS-Q-ST-70-02	Space product assurance — Thermal vacuum outgassing test for the screening of space materials
EN 16602-70-12	ECSS-Q-ST-70-12	Space product assurance — Design rules for printed circuit boards
EN 16602-70-28	ECSS-Q-ST-70-28	Space product assurance — Repair and modification of printed circuit board assemblies for space use
EN 16602-70-60	ECSS-Q-ST-70-60	Space product assurance — Qualification and procurement of printed circuit boards
EN 16602-70-71	ECSS-Q-ST-70-71	Space product assurance — Materials processes and their data selection
	ESA-STR-258	ESA-Approved skills training schools
	ESCC 23500 (September 2013)	Requirements for lead materials and finishes for components for space application

EN reference	Reference in text	Title
	IPC J-STD-004B-AM1 (November 2011)	Requirements for Soldering Fluxes
	IPC J -STD-033D (January 2018)	Handling, Packing, Shipping and Use of Moisture, Reflow, and Process Sensitive Devices
	IPC-TM-650 (latest edition)	Test methods manual. Surface Insulation Resistance, Fluxes
	ISO 9454-1:2016	Soft soldering fluxes; classification and requirements
	ISO 14644-1:2015	Cleanrooms and controlled environments
	MIL-STD-883 K Method 2009 (April 2016)	Test Method Standard, Microcircuits

Terms, definitions and abbreviated terms

3.1 Terms from other standards

- a. For the purpose of this Standard, the terms and definitions from ECSS-S-ST-00-01 apply.
- b. For the purpose of this Standard, the terms and definitions from ECSS-Q-ST-60 apply, in particular for the following term(s):
 1. commercial component
- c. For the purpose of this Standard, the terms and definitions from ECSS-Q-ST-70-28 apply, in particular for the following term(s):
 1. repair
 2. rework

3.2 Terms specific to the present standard

3.2.1 Approval Authority

entity that reviews and accepts the verification programme, evaluating the test results and grants the final approval

3.2.2 assembly sensitive component

component prone to have cracks in solder joint exceeding 75 % of acceptance criteria of solder cracks or showing nonconformance outside the component manufacturer limit

NOTE 1 ESA list of assembly sensitive components is published on ESCIES for information, see www.escies.org.

NOTE 2 Each company maintains its own list of assembly sensitive components in the PID.

3.2.3 bifurcated terminal

terminal containing a slot or split in which wires or leads are placed before soldering

NOTE The term "**split terminal**" is synonymous.

3.2.4 blister

delamination in form of localized swelling and separation between any of the layers of a laminated base material in a printed circuit board

3.2.5 bonding

application process of adhesive underneath a package for mechanical or thermal purpose

3.2.6 bridging

build-up of solder or conformal coating between components, component leads or base substrate forming an elevated path

3.2.7 clinch lead

conductor or component lead which passes through a printed circuit board and is then bent to contact the printed circuit board pad

NOTE The clinched portion is not forced to lie flat on the pad and some innate spring back is desirable before this form of termination is soldered.

3.2.8 cold flow

movement of insulation

NOTE For example, Teflon® (PTFE), caused by pressure.

3.2.9 cold solder joint

joint in which the solder has a blocky, wrinkled or piled-up appearance and shows signs of improper flow or wetting action

NOTE It can appear either shiny or dull, but not granular. The joint normally has abrupt lines of demarcation rather than a smooth, continuing fillet between the solder and the surfaces being joined. These lines are caused by either insufficient application of heat or the failure of an area of the surfaces being joined to reach soldering temperature.

3.2.10 conformal coating

thin polymeric film applied on a populated PCB that conforms to the shape of the surface it covers.

3.2.11 co-planarity

maximum distance between lowest and highest termination when component rests on flat surface

3.2.12 collective assembled components

set of components that are soldered to PCB in one operation

3.2.13 critical zone

area in the solder joint in which the existence and magnitude of cracks is subject to acceptance or rejection

3.2.14 dewetting

condition in a soldered area in which the liquid solder has not adhered intimately, characterized by an abrupt boundary between solder and conductor, or solder and terminal/termination area

NOTE This is often seen as a dull surface with islands of thicker shiny solder.

3.2.15 disturbed solder joint

unsatisfactory connection resulting from relative motion between the conductor and termination during solidification of the solder

3.2.16 dynamic wave soldering machine

system that achieves wave soldering and which consists of stations for fluxing, preheating, and soldering by means of a conveyor

3.2.17 electrical clearance

spacing between non-common electrical conductors on external layers of a printed circuit board assembly

NOTE The distance between conductors depends on the design voltage and DC or AC peaks. Any violation of minimum electrical clearance as a result of a nonconformance is a defect condition.

3.2.18 fillet

smooth concave build-up of material between two surfaces

NOTE Example: A fillet of solder between a component lead and a solder pad or terminal, or a fillet of conformal coating material between a component and printed circuit board.

3.2.19 flux

material which, during soldering, removes the oxide film, protects the surface from oxidation, and permits the solder to wet the surfaces to be joined

3.2.20 glass meniscus

glass fillet of a lead seal which occurs where an external lead leaves the package body

NOTE These can be described as either functional, where an active track is terminated, or non-functional, where the pad is isolated.

3.2.21 modal survey

characterization of the dynamic properties of systems in the frequency domain

NOTE A typical example is testing structures under vibrational excitation

3.2.22 outsourcing

act of subcontracting work to another company in compliance with customer PID

3.2.23 pin in paste

process where a through hole component is mounted and soldered in the surface mounting process

3.2.24 pits

small holes or sharp depressions in the surface of solder

NOTE This can be caused by flux blow-out due to entrapment or overheating.

3.2.25 potting compound

compound, usually electrically non-conductive, used to encapsulate or as a filler between components, conductors, or assemblies

3.2.26 pressfit connector

solderless termination technology where each contact is pressed into a plated hole of a printed circuit board creating a mechanical and electrical joint

3.2.27 reprocessing

preparatory operation done on a component prior to assembly

NOTE Degolding, pretinning, lead forming, and cutting are examples of reprocessing.

3.2.28 shield

metallic sheath surrounding one or more wires, cables, cable assemblies, or a combination of wires and cables that is used to prevent or reduce the transmission of electromagnetic energy to or from the enclosed conductors

NOTE The shield also includes an insulating jacket that can cover the metallic sheath.

3.2.29 solder balls

numerous spheres of solder having not melted in with the joint form and being scattered around the joint area normally attached by flux residues

NOTE Can be caused by incorrect preheating or poor-quality solder.

3.2.30 solder-cup terminal

hollow, cylindrical terminal closed at one end to accommodate one or more conductors

3.2.31 solder icicle

conical peak or sharp point of solder usually formed by the premature cooling and solidification of solder upon removal of the heat sources

3.2.32 solder pad

conductive surface on a printed circuit board to which terminations are soldered to form electrical connections

3.2.33 solder stand-off

thickness of solder between the underside of the component termination and the solder pad

3.2.34 split terminal

see "bifurcated terminal" 3.2.3

3.2.35 staking

application process of adhesive on the outside of a package for mechanical purpose

3.2.36 stress relief

method or means to minimize stresses to the soldered termination or component

NOTE Generally, in the form of a bend or service loop in a component lead, solid or stranded wire to provide relief from stress between terminations, as that caused, for instance by movement or thermal expansion.

3.2.37 stud termination

upright conductor termination through a printed circuit board

3.2.38 technology samples

samples of boards assembled with representative technology

3.2.39 thermal shunt

component with good heat-dissipation characteristics used to conduct heat away from an article being soldered

3.2.40 turret terminal

round post-type grooved stud around which conductors are fastened before soldering

3.2.41 underfill

material deposited between a component and substrate

3.2.42 verification board

substrate assembled with components subjected to a verification programme

3.2.43 wicking

flow of molten solder or cleaning solution by capillary action

NOTE Occurs when joining stranded wire; solder is drawn within the strands, but normally not

visible on outer surface of strands. Wicking can also occur within the stress relief bend of a component lead.

3.3 Abbreviated terms

For the purpose of this Standard, the abbreviated terms from ECSS-S-ST-00-01 and the following apply:

Abbreviation	Meaning
AAD	area array device NOTE: also known as "area array component"
AOI	automatic optical inspection
AWG	American wire gauge
BGA	ball grid array
CBGA	ceramic ball grid array
CCGA	ceramic column grid array
CGA	column grid array
CLCC	ceramic leaded chip carrier
CTE	coefficient of thermal expansion
DCL	declared component list
DIL	dual in line
DIP	dual in line package
DPAK	diode package
DRD	document requirement definition
EDX	Energy dispersive X-ray
ETFE	ethylene tetrafluoroethylene
EPA	ESD protected area
ESD	electrostatic discharge
FEP	fluorinated ethylene propylene
FM	flight model or flight hardware
FP	flat pack package
JEDEC	Joint Electron Component Engineering Council
LCCC	leadless ceramic chip carrier
MELF	metal electrode face bonded NOTE: MELF includes the terms "minimelf" and "micromelf"
MIP	mandatory inspection point
MPCB	Materials, Mechanical Parts and Processes Control Board
MRR	manufacturing readiness review

Abbreviation	Meaning
PCB	printed circuit board
PLCC	plastic leaded chip carrier
PID	process identification document
PSD	power spectral density
PTFE	polytetrafluoroethylene
PTH	plated through hole component
QFN	quad flat pack no leads
QFP	quad flat pack
R_g	resistance to ground
R_s	surface resistance
r.m.s.	root-mean-square
SEM	scanning electronic microscope
SIR	surface insulation resistance
SMD	surface mounted device NOTE: In the text of this document the term “component” is used instead of “device”
SMT	surface-mount technology
SO	small outline
SOD	small outline diode
SOT	small outline transistor
SOP	small outline package
TO	transistor outline
TRB	test review board
TRR	test readiness review
TSOP	thin small outline package
RF	radio frequency

3.4 Nomenclature

The following nomenclature apply throughout this document:

- The word “shall” is used in this document to express requirements. All the requirements are expressed with the word “shall”.
- The word “should” is used in this document to express recommendations. All the recommendations are expressed with the word “should”.

NOTE It is expected that, during tailoring, all the recommendations in this standard are either converted into requirements or tailored out.

- The words “may” and “need not” are used in this document to express positive and negative permissions respectively. All the positive

permissions are expressed with the word “may”. All the negative permissions are expressed with the words “need not”.

- d. The word “can” is used in this document to express capabilities or possibilities, and therefore, if not accompanied by one of the previous words, it implies descriptive text.

NOTE In ECSS “may” and “can” have a completely different meaning: “may” is normative (permission) and “can” is descriptive.

- e. The present and past tense are used in this document to express statement of fact, and therefore they imply descriptive text.

Principles of reliable soldered connections

The following are the general principles to provide reliable soldered connections:

- Reliable soldered connections are the result of proper design, control of tools, materials, processes work environments and workmanship performed in accordance to verified and approved procedures, inspection control and precautions.
- The basic design concepts to provide reliable connections and to avoid solder joint failure are as follows:
 - Stress relief is an inherent component which reduces detrimental thermal and mechanical stresses on the solder connections.
 - Where adequate stress relief is not possible materials are so selected that the mismatch of thermal expansion coefficients is a minimum at the constraint points in the component mounting configuration.
- The assembled substrates are designed to allow easy inspection, rework, and repair.
- The electrical and mechanical integrity of components and assemblies are retained after exposure to processes employed during manufacture and assembly, e.g., handling, baking, fluxing, soldering, and cleaning.
- Soldering to gold using tin-lead alloy can cause failure.

5

Preparatory conditions

5.1 Facility cleanliness

- a. Personnel facilities shall be separated from the soldering areas.

NOTE Example: Washrooms, eating areas, smoking facilities.
- b. Furniture shall be arranged to allow thorough cleaning of the floor.
- c. Areas used for soldering shall be kept free from contaminants.

NOTE Loose material such as dirt, dust, solder particles, oil or clipped wires can contaminate soldered connections.
- d. Working areas shall be kept free from any tools or equipment not used for the current task.
- e. Working surfaces shall be covered with an easily cleaned hard top or have a replaceable surface of clean, non-corrosive, silicone-free ESD compatible paper.
- f. Tools used during soldering operations shall be free of visible contaminant.
- g. Excess lubricants shall be removed from tools before soldering starts.

5.2 Environmental conditions

- a. The clean room shall be compliant to the requirements of clause 5.3.1 of ECSS-Q-ST-70-01.
- b. The soldering area shall have as minimum a cleanliness level of ISO Class 8.2 in accordance with ISO 14644-1 (2015).

NOTE Particle sizes for 8.2 are not mentioned in the ISO Standard and can only be calculated with the formula in Annex E of ISO 14644-1 (2015). See Table 5-1.

Table 5-1: Particle sizes classes 8 and 9 according to ISO 14644-1 (2015)

Particle sizes				
	0,5 µm	1 µm	5 µm	
ISO-class 8	3 520 000	832 000	29 300	From Table 1 of ISO
ISO-class 8.1	4 430 000	1 05 0000	36 800	Calculation acc ISO Annex E equation
ISO-class 8.2	5 570 000	1 320 000	46 400	Calculation acc ISO Annex E equation
ISO-class 8.5	11 100 000	2 630 000	92 500	From Annex E in ISO
ISO-class 9	35 20 0000	8 320 000	293 000	From Table 1 of ISO

- c. Areas used for assembly or cleaning of parts and areas where toxic or volatile vapours are generated or released shall include a local air extraction system.
- d. The room temperature of the facility shall be maintained at (22 ±3) °C.
- e. The relative humidity at room temperature of the facility shall be maintained at (55 ±10) %.
- f. The soldering area shall not be exposed to draughts.
- g. Air shall be supplied to the room through a filtering system that provides a positive pressure difference with respect to adjacent rooms.

5.3 Lighting requirements

- a. Lighting intensity shall be a minimum of 1080 lux on the work surface.

NOTE In selecting a light source, the colour temperature of the light is an important consideration. Light ranges from 3000 K-5000 K enable users to distinguish various printed circuit assembly features and contaminants with increased clarity.

- b. At least 90 % of the work area shall be without shadows or severe reflections.

5.4 Precautions against static discharges

5.4.1 Overview

Electronic components are particularly sensitive to electrostatic charging and discharging. To protect these components, it is necessary to define measures with regard to their handling, transport and storage.

The ESD control programme helps reducing to a minimum level the ESD-related damage to components. Main topics of the programme are:

- ESD coordinator,

- Training,
- Product qualification,
- Compliance verification,
- Grounding/bonding systems,
- Personnel grounding,
- EPA requirements,
- Packaging systems,
- Marking.

The controls referenced in this document have been selected from document “ANSI/ESD S20.20-2014 2.0 SCOPE”. The goal is to prevent damage of the isolated conductors and of the ESD sensitive devices (ESDS) which are susceptible to discharges that are greater than or equal to 100 V (Human Body Model) or 200 V (Charged Device Model).

5.4.2 General

- a. An ESD Control Programme in accordance with EN 61340-5-1 (2016) shall be developed and implemented by the supplier.

NOTE EN 61340-5-2 guideline can be used for editing the ESD Control Programme.

- b. The process for the selection of new components shall include their ESD sensitivity.
- c. Electrostatic sensitive components shall be handled, prepared, mounted, soldered, and cleaned in an ESD protected area.

NOTE Electrostatic sensitive components are classified in different categories. For some, additional ESD conditions to the nominal are needed.

- d. Electrostatic sensitive components shall be kept in appropriate ESD protected packaging.

NOTE For example, kept in shielded bags.

- e. Containers for ESD sensitive components shall be labelled as such.

5.4.3 ESD Protected Area

- a. ESD sensitive devices shall be assembled in an EPA.
- b. As a minimum, a dissipative mat, a wrist strap and common grounding facility for both shall be in place in the EPA.
- c. EPA areas shall be visibly marked as such.
- d. ESD rules and regulations shall apply as specified in EN 61340-5-1 (2016).
- e. If the measured electrostatic field or surface potential exceeds the stated limits, ionization or other charge mitigating techniques shall be used.

- f. Relative Humidity shall be controlled in the EPA in accordance with requirement 5.2e.

5.4.4 Precautions against ESD during manufacturing

- a. Delimited EPA and corresponding ESD control items shall be in compliance with Table 5-2.
- b. Ionized air in presence of high voltage or RF shall be used in compliance with components manufacturer recommendations.

NOTE Static charges on isolated components or tooling can be dissipated using ionised air.

- c. A wrist strap shall be worn by the operator.
- d. Powered equipment at the workstation shall be grounded.
- e. The normal value of the resistance between the tip of the soldering system and the ground of the ESD protected area shall not exceed 5 Ω .

NOTE The measurement is generally performed at soldering temperature.

- f. A ground-fault circuit interrupter shall be installed.
- g. Protective clothing shall be made from static dissipative material.
- h. Gloves and finger cots shall be made from static dissipative material.
- i. Tools, such as mounting aids, consumables, masking tape, shall be conductive or static dissipative.
- j. Paperwork accompanying ESD sensitive components shall be contained in static dissipative bags or envelopes.

NOTE Example of accompanying paperwork are traveller logs, drawings, and instructions.

- k. Paperwork shall not come into contact with ESD sensitive components.

Table 5-2: EPA requirements summary

ESD Control item		Limits values * (unit: Ω)
Working surfaces, storage, racks and trolleys	Dissipative top surface	$R_s < 1 \times 10^9$
	ESD protected to ground	$R_g < 1 \times 10^9$
Flooring	ESD protected to ground	$R_g < 1 \times 10^9$
Ionization		Decay (1000 V to 100 V) in less than 20 s Offset voltage $\pm 35V$
Seating	ESD protected to ground	$R_g < 1 \times 10^9$
Wrist strap	ESD protected to ground	$R_g < 5 \times 10^6$
* Values are taken from Table 3 of EN 61340-5-1:2016.		

5.4.5 Protective packaging and ESD protection

- a. All ESD-sensitive items shall be contained within ESD-protective containers for movement between and within ESD-protected areas.
- b. ESD protective packaging shall display ESD warning signs.
- c. If the packaging is not ESD safe, it shall be labelled accordingly.

NOTE The objective of ESD protection is to prevent ESD to the item contained within, to allow for dissipation of charge, and to prevent charging of the ESD item by an external electrostatic field.

- d. A container providing mechanical and ESD protection shall be used, whenever the ESD-sensitive electronic assembly is transported within a manufacturing plant or during shipment to external destinations.

NOTE This can be achieved by a container with:

- an outer shell that provides adequate mechanical protection for the contents,
- foam or bubble wrap shock absorbing liners that have static shielding covers,
- shielding package for the ESD sensitive contents.

- e. All static-shielding bags shall be metallized.
- f. Bags, film, bubble wrap or foam of Pink-Polyethylene shall not be used near any ESD-sensitive item or within an ESD protected area.

NOTE Pink-polyethylene (pink-poly) provides little protection against ESD events and voltage fields and is a contaminants source.

- g. Shipping popcorn, foam liners and polystyrene foam shall not be used near ESD-sensitive items unless shielding overwrap protects them.

5.5 Equipment and tools

5.5.1 General

- a. Any equipment and tools shall be inspected to meet requirements from clause 17.4.
- b. Status of tools and inspection equipment shall be verified according to clause 17.4.
- c. All tools and inspection equipment shall be maintained and calibrated, and their results recorded.
- d. Equipment shall not generate, induce, or transmit electrostatic charges to components being placed.
- e. Any machine or part of machine, in particular the conveyor, shall be grounded to avoid electrostatic discharge.

- f. Machines and equipment used to solder surface mount components shall either be a type incorporating dynamic single or dual solder wave or be of the solder reflow type.
- g. The supplier shall verify, based on the available documentation, that degolding, pretinning and soldering conditions do not exceed the values given by the individual component data sheets.

NOTE Examples of soldering conditions include maximum temperature to avoid internal melting, thermal shocks, thermal damages, removal of marking ink, degradation of encapsulating plastic.

- h. Temperature and time profiles for assembly shall be identified by the supplier and approved by the Approval Authority.
- i. The supplier shall identify changes and implement a verification programme in compliance with the requirements from clause 13.
- j. The supplier shall demonstrate the reproducibility of their processes.

5.5.2 Brushes

- a. Medium-stiff natural- or synthetic bristle, ESD-safe, brushes shall be used for cleaning provided that they do not damage any surface to be cleaned or adjacent materials.

NOTE Brushes with wooden handle can be used.

- b. Brushes shall be cleaned in a solvent in accordance with clause 6.4.
- c. Brushes shall not be damaged by the solvents used for PCB cleaning.
- d. Wire brushes shall not be used.

5.5.3 Cutters and pliers

- a. Cutting edge profiles and cutter usage shall be in accordance with Figure 5-1.
- b. The cutter used for trimming conductor wire and component leads shall shear sharply, producing a clean, flat, smooth-cut surface along the entire cutting edge.

NOTE 1 These measures minimize the transmission of mechanical and shock loads to delicate components.

NOTE 2 Smooth, long-nose pliers or tweezers can be used for attaching or removing conductor wires and component leads.

- c. No twisting action shall occur during the cutting operation.
- d. Cutting edges shall be checked for damage and maintained in a sharp condition.

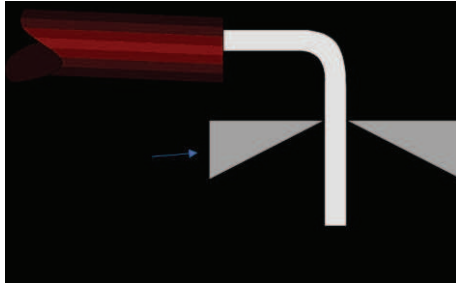


Figure 5-1: Profile of correct cutters for trimming leads

5.5.4 Bending tools

- a. Component leads shall be bent or shaped using tools, including automatic bending tools, which do not nick or damage the leads or insulation.
- b. Components shall not be damaged by the bending process specified in clause 8.2.7.

NOTE It is good practice to use bending tools with polished finish. The preferred surface finish for shaping tools is hard chromium plating.

- c. Bending tools shall have no sharp edges in contact with the component leads.
- d. A maximum reduction of 10 % of initial section may be acceptable provided that it is representative of the verified configuration.

5.5.5 Clinching tools

- a. Clinching tools shall not damage the surfaces of printed-circuit conductors, components or component leads.

5.5.6 Insulation strippers

5.5.6.1 Thermal strippers

- a. The temperature of the stripper shall not burn, blister, or cause excessive melting of the insulation.

NOTE 1 Thermal insulation strippers can be used for wire insulation types susceptible to damage by mechanical strippers.

NOTE 2 It is good practice to apply thermal strippers for use with AWG 22 and smaller wire sizes where there is a possibility of the wire stretching if a mechanical stripper is used.

NOTE 3 Local air extraction units can be used during thermal stripping.

5.5.6.2 Precision mechanical cutting-type strippers

- a. Mechanical strippers shall be of the following types:
 1. Automatic power-driven strippers with precision, factory-set, cutting, and stripping dies and wire guards, or
 2. Precision-type hand strippers with accurately machined and factory-pre-set cutting heads.

NOTE Figure 5-2 shows an example of acceptable mechanical strippers.

- b. Stripping tools or machines shall fit the size of the wire conductor.

NOTE It is good practice to mask off the die openings for wire sizes not in use.

- c. The conductor shall not be twisted, ringed, nicked, cut, or scratched by the process.

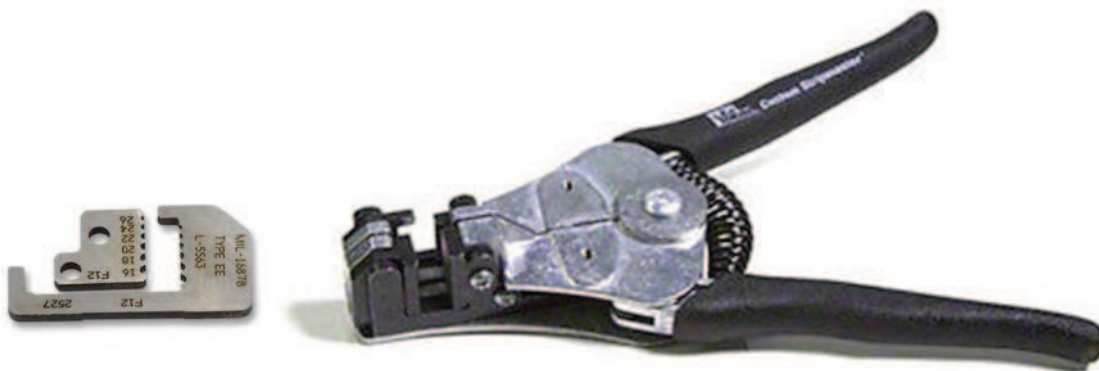


Figure 5-2: Example of suitable mechanical strippers

5.5.6.3 Enamel stripping for wires

- a. The enamel shall be removed by chemical or thermal means.
- b. The enamel may be removed by mechanical means provided that visual inspection using a minimum magnification of x40 is carried out to confirm absence of damage of the conductor.
- c. When stripping the ends of enamel wires the complete removal of the enamel shall be verified by visual inspection.
- d. Chemical stripping materials shall be completely neutralised and be cleaned such that there are no residues from the stripping, neutralizing, or cleaning steps.
- e. The enamel shall not be visually contaminated by the stripping process.

5.5.6.4 Verification of stripping tools

- a. Thermal and mechanical stripping tools shall be verified by removal of insulation at the start of each production batch.